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BULLETIN

OF THE

TORREY BOTANICAL CLUB

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Vol. 50 No. 3

BULLETIN

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TORREY BOTANICAL CLUB

MARCH, 1923

Polyembryony developed under experimental conditions in certain polypodiaceous ferns

AUSTIN ETTER

(WITH PLATE 4 AND SEVEN TEXT FIGURES)

Among liverworts and in many mosses, polyembryony, or the development of two or more sporophytes upon a single gametophyte, is the rule rather than the exception. Among the Pteridophytes, however, the phenomenon is of less frequent occurrence.

While experimenting with prothallia by lighting them both above and below, Heinricher secured two perfect embryos on one prothallium, one above and one below. The value of this as an example of polyembryony was questioned by Atkinson ('93) in that it might be considered an abnormal case.

As stated by Atkinson ('93), "Rauwenhoff ('89) notes the development of two embryos on single prothallia of *Gleichenia*. In both of these cases, however, we are not informed of the comparative strength or advanced condition of growth of the embryos, so that it may be an open question whether both of the embryos on a single prothallium could have developed into independent plants." In at least one other instance, however, Rauwenhoff ('91) described and figured, according to Buchholz ('22, p. 263), polyembryony in *Gleichenia*, indicating the relative size and condition of the two embryos.

During his study of *Osmunda*, Campbell ('92) observed two embryos on one prothallium, one of which was much smaller

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than the other and would probably have been starved out by the larger one before it could have become independent of the gametophyte.

Farmer ('92), while working out the embryogeny of *Angiopteris evecta*, observed and figured a prothallium bearing two young sporophytes, widely separated and perhaps located on two different archegonial cushions.

Atkinson ('93) reported a case of "two independent plants from the same prothallium" in *Adiantum cuneatum*.

In *Botrychium Lunaria* Bruchmann ('06) found that, in several prothallia examined, two embryos had started to develop, but in no instance were three found on one gametophyte.

A number of large sporophytes and embryos were found by Lang ('14) in single *Helminthostachys* prothallia. Most of the embryos were small and aborted when found on prothallia with larger successful plants. He further observed that a number of archegonia must have been fecundated simultaneously in a few cases of prothallia which were attached to young sporophytes.

Jeffrey ('98) during his work on *Botrychium virginianum* observed in one instance two sporophytes on a single prothallium.

Campbell ('21, p. 147) found in *Botrychium obliquum* that one-celled embryos were common, as several archegonia may be fecundated and begin to form embryos, the inference being that two or more unicellular embryos were seen on a single prothallium.

Czaja ('21, p. 565) succeeded in four out of six attempts in causing two embryos to develop on one prothallium of *Gymnogramme chrysophylla*, and observed that both embryos of a single prothallium developed almost equally, but stated that these facts were not at all surprising since they were borne on old vigorous prothallia with large archegonial cushions.

In a species of *Aspidium*, probably *Aspidium Thelypteris*, collected in its natural habitat, Buchholz ('22, *f. 24*) illustrates the occurrence of plural embryos. Two embryos were figured on a single prothallium, one of which had approximately 25–30 cells; the other one was unicellular and was located about 1 mm. back of the sinus on the remote side of the archegonial cushion. He also illustrates (*l.c., f. 25*) what he believes to be a slightly later stage indicating the fate of the smaller embryo. The larger embryo (*l.c., f. 25A*) in this case had apparently attained

a size of approximately 300–400 cells; while, in his *f. 25B*, is shown what he believes to be a unicellular embryo, with disintegrating nucleus, collapsing, as it seems to have been aborted through embryonic competition. This might have been only an old egg-cell disintegrating. The venter indicates no decided development as should be expected in the presence of a zygote. If this, however, is a unicellular embryo, three or four, and probably more, have been observed by me during this study on the same gametophyte along with one or two other larger embryos.

In preparing demonstrations for class use observers have noted the occurrence of two or three and possibly four embryos per gametophyte, but embryos that had reached the stage with the first leaf evident were not reported. When small embryos were observed along with a much larger embryo on the same prothallium, it was noted that the smaller ones were evidently suffering from the competitive struggle, as was apparent by the shrunken appearance of the cells (see Buchholz, '22, p. 264).

Goebel ('87) reported the occurrence of several embryos on individual prothallia of *Vittaria*, some of which bore also a larger sporophyte in addition, and stated further that he had no doubt that several sporophytes might come from a single prothallium.

Among the Lycopodiales and Equisetales the occurrence of two to several embryos per gametophyte has been reported and figured in many instances.

Up to the present time little attention has been devoted to the subject of polyembryony in ferns, and especially to the development of polyembryony experimentally.

This investigation was undertaken for the purpose of determining whether or not polyembryony existed in *Matteuccia Struthiopteris* (L.) Todaro (*Onoclea Struthiopteris* Hoffm.). It was later extended to include *Onoclea sensibilis* L., *Dryopteris mollis* (Jacq.) Hieron., and *Pteris longifolia* L., and the attempt was made to determine to what extent plural embryos could be developed experimentally.

MATERIALS AND METHODS

The spores of *Matteuccia Struthiopteris*, from which the prothallia were grown, were obtained through the courtesy of

Professor Henry F. A. Meier of Syracuse University, Syracuse, New York.* Spores of *Onoclea sensibilis* were collected by the writer in the vicinity of Indiana University, while those of *Dryopteris mollis* and *Pteris longifolia* were secured from plants grown in the departmental greenhouse.

The same methods were used for all the species, excepting the prothallia of *Pteris longifolia*, which were transplanted without being examined under the microscope.

The spores were sown on rich soil from the woods. The soil was sterilized at approximately 100° F. in earthen saucers, in a steam sterilizer, for a period of two to six hours, permitted to cool, and surfaced with a rather thick sowing of spores. The cultures were kept on tables under ventilated bell-jars in the greenhouse, where ordinary greenhouse conditions existed. They were sub-irrigated with distilled water from time to time as needed. The first green of the surface appeared in from five to eight days.

Archegonial prothallia were selected for experimental purposes when they became 3–5 mm. across the lobes. All prothallia were removed from cultures and cleaned sufficiently in distilled water to permit of a good examination. They were then transferred to a drop of distilled water on a slide and carefully examined. If archegonia were open and no spermatozoids present a few male prothallia were placed near the sinus and the whole covered with a cover glass. The sperms were followed to the egg-cells under the microscope. The gametophytes were then left on the slides with cover glass removed, or placed in a ventilated moist chamber for about thirty minutes. On account of class room pressure some of them were permitted to remain in this condition for three or four hours. Results secured in both cases were the same. All archegonial prothallia were then very carefully transplanted about an inch apart on moist soil, care being taken that the specimens were not too wet for twenty-four hours. The soil and air were just moist enough to keep the prothallia in good condition. After periods of from five to twenty-six days the gametophytes were harvested for study.

* In all probability the spores used were American in origin and would therefore represent *M. nodulosa* (Michx.) Fernald (*Pteretis nodulosa* Nieuwl.), rather than the true *M. Struthiopteris* of Europe (see Fernald, Rhodora 17: 164. 1915).

Those that were to be used for histological study were fixed in dilute chrom-acetic acid of the following composition, chromic acid 1 gram, glacial acetic 4 cc., water 450 cc., for thirty-six to forty-two hours, and gradually brought into paraffin with chloroform as the solvent. The prothallia were thoroughly cleaned of earth and all foreign matter as soon as they had reached the grade of 50 per cent alcohol in the dehydrating process. At this step to facilitate handling the small prothallia were stained *in toto* in borax carmine. The serial sections, 7–8 μ thick, were stained on the slide with safranin, gentian violet, and orange G, the last stain being dissolved in clove oil.

Also, during these researches a considerable number of prothallia were divided longitudinally through the midrib. Gametophytes bearing embryos were selected from ordinary cultures, cleaned somewhat, and transferred to moistened Bristol board on the stage of a dissecting microscope where, with a very sharp scalpel, a clean cut was carefully made through the cushion. Those which bore no perceptible embryos from observation with a hand-lens were divided on the soil and carefully transplanted to sterilized saucers of soil.

OBSERVATIONS AND RESULTS

In each of almost nine hundred prothallia fecundated and transplanted, one to several spermatozoids were observed to enter and pass down the necks of from two to ten archegonia. That is, sometimes there were but two archegonia open when male plants were placed near the sinus, and again there were a number up to a maximum of ten open at that time.

At the beginning of the work quite a number of prothallia were taken from ordinary cultures, imbedded, sectioned, and examined, for the simple purpose of becoming acquainted with the material, *Matteuccia Struthiopteris*, to be used in the experimentation. During this time two and three eggs were observed on a single gametophyte, each of which bore several sperm nuclei.

Prothallia which were left on the soil for from five to ten days brought the best results. When it was apparent that more than one embryo was present on a prothallium, serial sections were made to determine definitely the facts in the case. On the prothallia of from five to ten days standing it was not always

possible to determine the presence or absence of embryos and their number, but after some experience it was not at all difficult to be reasonably sure, so that only those prothallia with two or more embryos were fixed, and after fifteen days it was rarely necessary to section, although it was always done when there was any room for doubt.

The vigorous gametophytes, 3–5 mm. across the lobes at the time of fecundation, gave better results than the older ones, although polyembryony was found among prothallia 6–8 mm. across the lobes. This may be accounted for by the fact that the young prothallia adjusted themselves more readily to the new environment when transplanted than did the older ones, although in each case the same care was used in handling.

In some instances two embryos developed almost equally, and beyond a doubt would have become independent sporophytes; this is well illustrated by PLATE 4, FIGS. 1–3. FIG. 1 is a diagram of a longitudinal section of a prothallium seven days after fecundation, illustrating the location of two embryos of almost equal size about 0.5 mm. apart on the archegonial cushion. Each embryo has approximately seventy-five to one hundred cells, and the meristematic condition of the venters is indicative of all that should be expected in healthful embryos. FIG. 3 (*b*, of FIG. 1) was slightly to one side and a little back of FIG. 2 (*a*, of FIG. 1). The embryo of FIG. 2 may have a few more cells, but it is located slightly nearer the sinus.

FIG. 4 is a diagram of a longitudinal section of a prothallium ten days after fecundation, showing the location of two embryos of very unequal size (*a* and *b*). It is clearly evident that the smaller embryo (*b*) is being starved or at least that some factor is working to its disadvantage. The larger embryo (*a* and FIG. 5), on the contrary, is normal in all respects. If these embryos had been on a more vigorous gametophyte, there is little doubt that they would have become independent in their existence, but such is not to be expected from the common run of prothallia, especially when one embryo is considerably nearer the sinus.

To determine what would result from a fecundated egg in a prothallium which had an embryo already started at the time of selective fecundation, several very vigorous prothallia were selected each of which bore an embryo about twenty-five days

old. Several archegonia were open in each instance. After eight days the harvesting was done, and TEXT FIG. 1 illustrates one of the results obtained. The smaller embryos were all in very good condition but doubtless would have soon succumbed. It is especially interesting to note that *a*, *b*, and *c* were closer to the sinus than was the dominate sporophyte. This difference in position probably largely accounts for the existence of the smaller embryos.

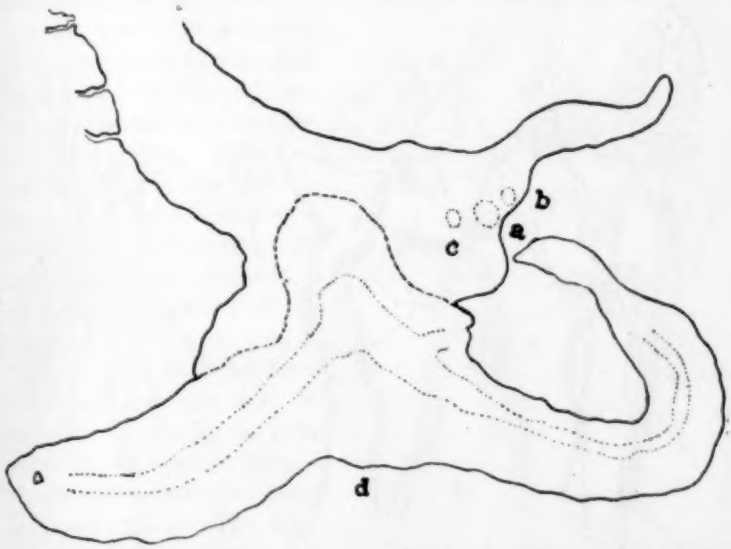

FIG. 1. Three embryos and a young sporophyte on a single prothallium of *Matteuccia Struthiopteris*. *a*, embryo probably in octant stage; *b*, embryo two-celled; *c*, embryo two-celled; *d*, young sporophyte about thirty-two days old.

TEXT FIG. 2 is from a gametophyte of *Pteris longifolia* with two independent sporophytes. These were fine vigorous individuals, well back from the sinus, and distinctly separated on the two sides of the archegonial cushion. *Pteris longifolia* lends itself very well to experimentation; it is a vigorous grower, and it is not at all surprising that it may bear plural embryos under natural conditions.

To determine just what would happen if a prothallium bearing two embryos were halved, several such gametophytes were selected from ordinary cultures and carefully divided by the

method stated in the foregoing. In three instances both embryos were left on one lobe. In each case the embryos came to independent existence and grew well. Ten prothallia were divided so that there was one embryo on each half. Six of the ten cases in this experiment developed and came to independent existence. This demonstrates the fact that a portion of a prothallium is capable, when isolated, of supporting a young sporophyte.

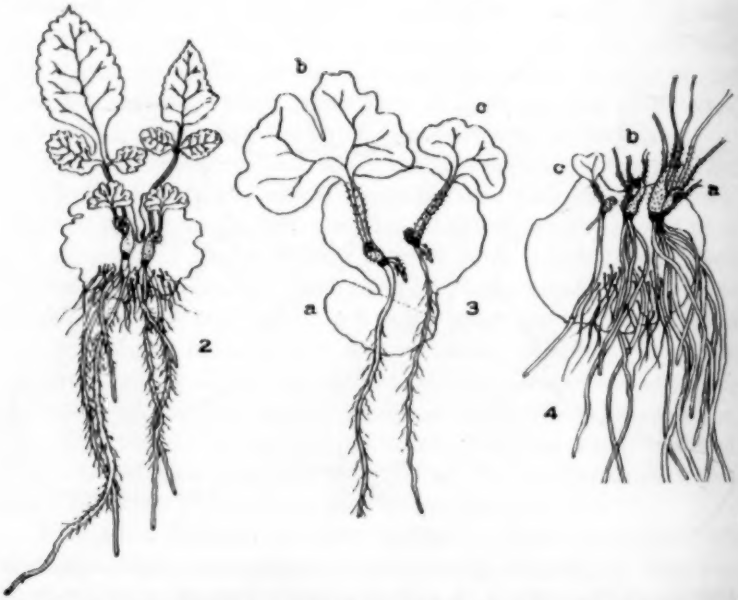

FIG. 2. Two sporophytes on a single gametophyte of *Pteris longifolia* (as seen from the ventral view), located on opposite sides of the archegonial cushion and well back from the sinus.

FIG. 3. Regenerated lobe of a prothallium of *Dryopteris mollis*, bearing two normal, thrifty, young sporophytes, *b* and *c*, widely separated on the archegonial cushion. *a*, the old half of the original prothallium.

FIG. 4. Three sporophytes on a regenerated lobe of *Matteuccia Struthiopteris*. They came in the order as lettered.

Two hundred seven prothallia, 3–5 mm. across the lobes, of the various species, which bore no embryos, were then divided longitudinally through the apical sinus. Apparently very little inconvenience was suffered by these severed parts. They recovered readily and less than 2 per cent of the prothallia were

lost. In every instance the severed halves either developed an embryo-sporophyte within six to ten days or regeneration began. The regenerated part was always more vigorous than the part from which it came. In as much as the regenerated parts always became monoecious, water was added from time to time to the individual prothallia, and there were permitted to dry somewhat each time before watering, in order to insure fecundation.

TEXT FIG. 3 shows two independent sporophytes which developed on the archegonial cushion of a regenerated lobe. The old lobe is shown at *a*. It is interesting to note that the regenerated lobe is larger and much more vigorous than the older one. The new lobe did not produce an apical sinus in this instance, although a well-formed archegonial cushion occupied a considerable portion of its extent.

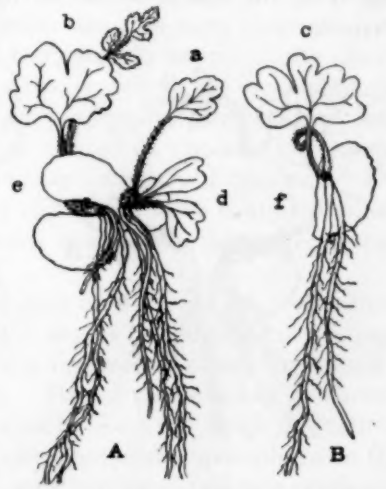

FIG. 5. A typical result obtained by dividing a gametophyte of *Matteuccia Struthiopteris* into longitudinal halves. *A*, two sporophytes on one regenerated prothallium, *e*; *a*, the older sporophyte; *b*, the younger sporophyte; *d*, the old half of the original prothallium. *B*, the other half, *f*, of the original prothallium upon which a sporophyte, *c*, soon began to develop.

The fact that at least three sporophytes may be induced to develop to independent existence from a single lobe is well illustrated in TEXT FIG. 4. The original lobe, from which the new one came, was absorbed, and this very vigorous new lobe grew to a width of 10 mm. without forming a sinus, before a sporophyte, *a*, appeared, fifty-four days after the dividing of the original gametophyte. Twenty-six days later another sporophyte, *b*, came near the first. After a lapse of twenty-nine days more a third sporophyte, *c*, came. The first and the second sporophytes grew as well as one should expect, while the third grew very slowly but otherwise normally. All three of them would doubtless have become independent sporophytes.

Regeneration usually produced a new normal heart-shaped gametophyte on which two sporophytes commonly developed, as is illustrated by TEXT FIG. 5, *A*. The larger sporophyte, *b*, was seen later than the smaller one, *a*. It is interesting to note here that the smaller one, although older, was not doing as well as the younger one, which was located nearer the apical sinus of the regenerated part. That more nutritious food is available there seems reasonable. TEXT FIG. 5, *B*, *c*, is a sporophyte which developed on the other original lobe near the region of the apical sinus, no regenerated part having been formed.

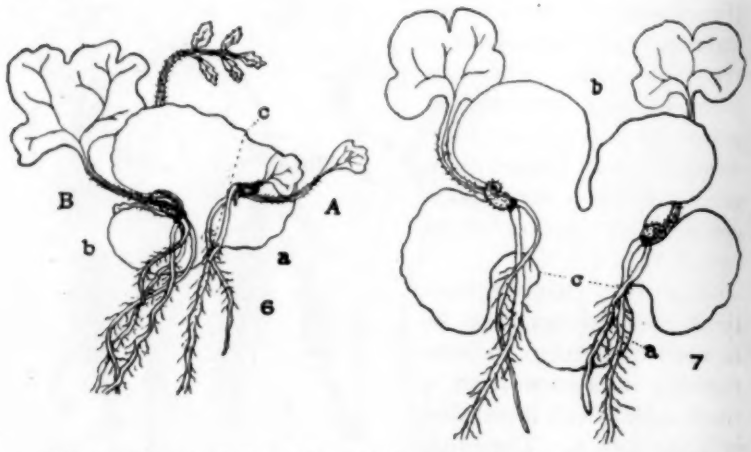

FIG. 6. Gametophyte of *Dryopteris mollis* bearing two sporophytes. *A*, older sporophyte on the old half of the original gametophyte, *a*; *c*, in approximately the boundary line between *A* and *B*. *B*, the regenerated gametophyte, *b*, bearing the younger but more thrifty sporophyte.

FIG. 7. Two sporophytes on regenerated prothallium of *Matteuccia Struthiopteris*; *a*, old half of original prothallium; *c*, approximate boundary line between the old and new parts; *b*, the regenerated prothallium.

It was not uncommon to find that, after a regenerated part had attained a width of 7–8 mm. across the lobes, a sporophyte came from the old original part ahead of one on the regenerated part. From all appearances the entire prothallium, including old and new parts, was morphologically one with the old midrib branched. This phenomenon is illustrated in TEXT FIG. 6. The smaller but older sporophyte, *A*, came well back on the broadened cushion, six days previous to the appearance of the

larger one, *B*, which, however, soon outstripped the older in development. The whole was transplanted, and four months later, at the time of this writing, both sporophytes are still growing but *B* is far in advance of *A*.

TEXT FIG. 7 shows two widely separated embryos of *Mattenccia Struthiopteris*, each one near a sinus of a regenerated part, both of which came from one half of the previously divided prothallium. Both sporophytes appeared about the same time and developed slowly, although about equally, as illustrated. This sort of occurrence was not as common as that in which only one part was regenerated, yet several instances like this were observed. At this time it is impossible to say just what the nature of the development of the archegonial cushion is, but we are inclined to the notion that the original cushion has simply branched, and that therefore both sporophytes are located on one cushion instead of on two independent and remote archegonial cushions. The condition illustrated by TEXT FIG. 7 was more common among gametophytes of *Dryopteris mollis* than among any other species studied.

A few prothallia were quartered by dividing the prothallium longitudinally and then at right angles to the first cut through the archegonial cushion. In one instance one quarter started a sporophyte within a few days. Two of the remaining quarters regenerated new normal prothallia, each of which brought a sporophyte, and one of these also produced a sporophyte on the older part. The remaining quarter produced two new prothallia which in turn developed two sporophytes. In another instance two of the quarters regenerated new normal prothallia from which sporophytes came; the remaining two proliferated quite a number of prothallium-like forms, from which no sporophytes had developed at the time of this writing.

SUMMARY

Polyembryony in *Matteuccia Struthiopteris*, *Onoclea sensibilis*, *Dryopteris mollis*, and *Pteris longifolia* may occur, though not frequently, in ordinary cultures and perhaps in nature.

Under experimental conditions two to several embryos may be made to develop on a gametophyte of the above named species.

In prothallia that have been divided longitudinally, each half may be made to grow and to develop two or more embryos.

In some cases each half may regenerate one or two heart-shaped lobes on which an embryo or embryos may be produced, as well as on the original half.

Parts of quartered prothallia under favorable conditions may continue growth and develop sporophytes.

When the gametophyte of a polypodiaceous fern is of sufficient vigor one to several or many normal embryos or sporophytes may be nourished and brought to independent existence.

This investigation was done under the direction of Professor D. M. Mottier, at Indiana University, and I wish to express my thanks to him for his invaluable aid in the work and for the helpful criticisms given during its course.

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BLOOMINGTON, INDIANA

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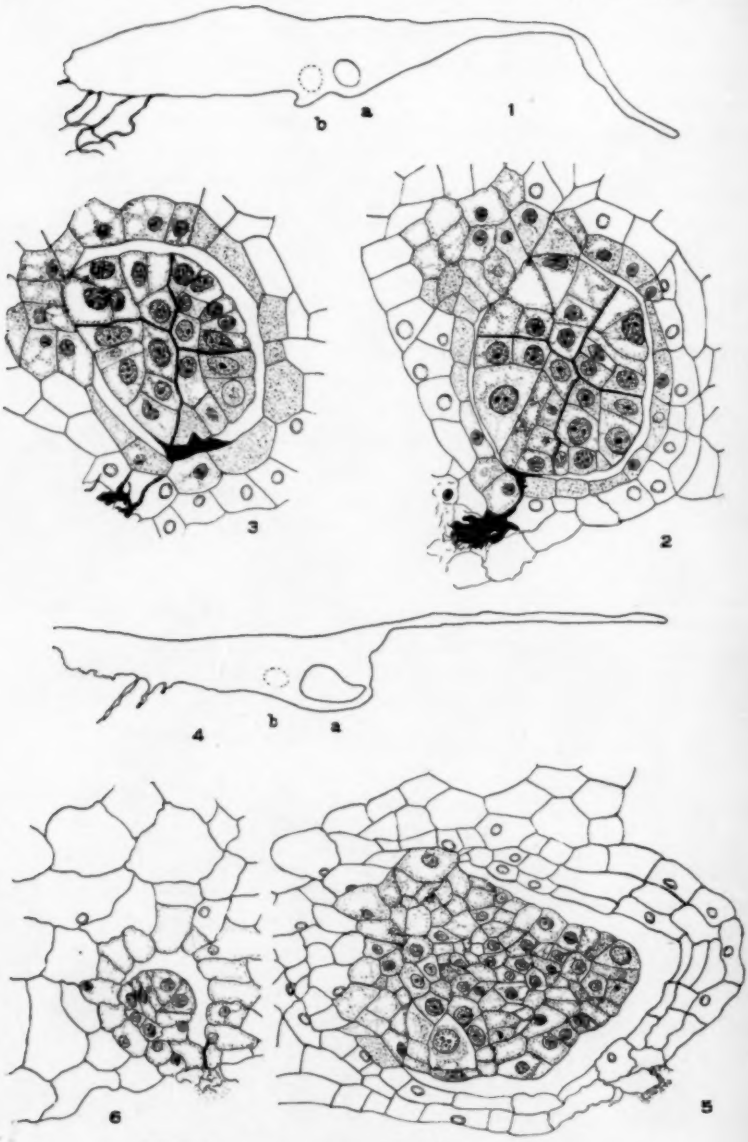

ETTER: POLYEMBRYONY IN FERNS

Explanation of plate 4

Polyembryony in Matteuccia Struthiopteris

Fig. 1. Outline of longitudinal section of a prothallium, showing position of two small embryos, *a* and *b*.

Fig. 2. Longitudinal vertical section of embryo *a* of Fig. 1, with surrounding cells of prothallium.

Fig. 3. The same of *b*, Fig. 1.

Fig. 4. Outline of longitudinal section of prothallium showing position of the two embryos *a* and *b*; *a* is much larger than *b*.

Fig. 5. Longitudinal vertical section of enbryo *a* of Fig. 4, with surrounding cells of the prothallium.

Fig. 6. Same of embryo *b* of Fig. 4. This smaller embryo was abnormal and probably would not have developed into an independent sporophyte.

The genus Heliocarpus

E. E. Watson

The latest literature, treating of the genus *Heliocarpus*, consists of two articles by Rose* and a review of the first of these by E. G. Baker.† A perusal of these articles and the examination of a large number of specimens of the genus in the herbarium of the New York Botanical Garden, in the herbaria of Columbia and Harvard Universities, and in the United States National Herbarium, all of which institutions very kindly loaned their specimens, suggested the desirability of a general review of the genus at this time.

The genus was established by Linnaeus in 1737 in the Hortus Cliffortianus. Here appeared his description of a new genus and species, which he called *Heliocarpos americana* ‡ together with a drawing of a portion of the plant. In the Species Plantarum, 1753, Linnaeus merely refers the reader to the description of *Heliocarpos americana* in the Hortus Cliffortianus. It is to be noted that Linnaeus preserved no specimen in his herbarium. There are, however, specimens labeled *H. americana* in the Banksian and Sloane Herbaria.

In 1821 the description of *H. popayanensis* H. B. K. appeared. This description is quite full and the differences between the new species and *H. americana* are clearly pointed out. This

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* A synopsis of the species of *Heliocarpus*. Contr. U. S. Nat. Herb. **5**: 125–129. *pl. 7–10.* 1897.

Notes on *Heliocarpus*, with new species. Ibid. **8**: 315–317. 1905.

† Two old American types. II.—*Heliocarpus americana* L. Jour. Bot. **36**: 130 132. 1898.

‡ The correct gender of the noun *Heliocarpus* has been in much dispute. In general, Latin or latinized names of plants and especially of trees are feminine, but the rule has numerous grammatically acknowledged exceptions. Classical Latin authors are by no means unanimous, and not always consistent, the same plant name being treated sometimes as masculine and sometimes as feminine by the same author. Linnaeus considered the noun feminine, so do Baker and Rose. Most other botanists, however, who have used the noun *Heliocarpus* have considered it masculine; and most other plant names ending in *-carpus*, are usually treated as masculine. If we are to consider *Heliocarpus* feminine, consistency would demand the same gender for all such plant names. It would seem unwise, therfore, to oppose the momentum of long-established usage in an unimportant detail.

was followed in 1857 by Seemann's publication of *H. arborescens*, which does not belong in this genus. In 1858, Turczaninow added three species, *H. tomentosus*, *H. appendiculatus* and *H. trichopodus*, and, five years later, *H. oblongifolius*.

In 1886, Schumann, unable to accept the seven described species, reduced them all to *H. americanus* with the two varieties *typicus* and *popayanensis*. His argument is based upon the existence of intermediate types. It is quite evident from his article that he had a very limited amount of material and that his examination was not very minute, for most of these species are distinct even to a casual observer.

Schumann cites for *H. americanus* var. *typicus: Regnell III. 285* from Brazil, *Mosen 3825*, *Riedel 424*, *Balansa 2295*. Of these I have seen only *Regnell III. 285*, which does not resemble *H. americanus* in the least. Schumann does not mention separate types for his two varieties, and the specimens cited include, as might be expected, widely varying plants.

In the same year, Sereno Watson published descriptions of three new species, *H. Palmeri*, *H. polyandrus*, and *H. attenuatus*, all clearly distinct. Eleven years later, Robinson added *H. glanduliferus*, characterized by red glands on the stem and excessive glandulosity of the lower serrations of the leaves. At about the same time, Rose published, in the first of the papers already noted, a synopsis of the genus in which he enumerated fifteen species, including several of his own. The following year E. G. Baker published his brief review of Rose's synopsis, offering some remarks on the earlier species, and endeavoring to establish the identity of *H. americanus*.

It may be well, at this point, to interrupt our chronology to discuss this type of the species. The situation is peculiar. It must be remembered that Linnaeus preserved no specimen of the plant he described, and his description is only fairly complete. The drawing represents a plant with stipules and without either fruits or flowers. As stipules in this genus are early deciduous, and as the drawing presents neither fruit nor flower, we conclude that the drawing is from an immature plant. On the same plate, however, is a drawing of a single fruit, which, so Linnaeus informs us, was sent to him by Miller, presumably from the Chelsea Garden. It is not explicitly stated that the two drawings were made from parts of the same plant. Nor

does it appear from Linnaeus' writings just what was the source of the plant in the Clifford Garden at Chelsea. The matter is made still more obscure by the fact that we have only one or two plants in the various herbaria that even remotely resemble Linnaeus' drawing or fit into his description. Baker discusses at some length the probable identity of the specimens in the Banksian and Sloane Herbaria, labeled *H. americana*, and concludes, no doubt correctly, that they are the same as *H. tomentosus*, and accordingly reduces the latter to synonymy, ignoring the fact that these Banksian and Sloane specimens in no wise agree with Linnaeus' drawing or description. His assumption that these specimens represent the same plant that Linnaeus had in mind does not follow at all, and is, indeed, in view of the evidence, most improbable. What the Banksian and Sloane specimens may be has nothing whatever to do with the question at issue—the identity of Linnaeus' plant. Since Linnaeus preserved no specimen, the only criteria we have are his drawing and description; and, as already stated, these do not agree with the Banksian and Sloane specimens at all. We are, however, indeed fortunate in possessing a specimen which does agree in all essential particulars with the drawing and description, and that specimen is *Fendler 1277 B*, from Venezuela, in the Gray Herbarium. This plant has lobed leaves, and these, together with the stems and petioles, are "fere glabra," as Linnaeus says. It is true that Linnaeus does not mention the long appressed hairs on the upper surface of the leaves, but except in this single particular the whole plant answers very satisfactorily to all the specifications.

Baker emphasizes also the probability that the plant in Clifford's garden came from Vera Cruz, and that it was *H. tomentosus*, the most abundant species in that vicinity, but it is far from proved. It is simply impossible that Linnaeus could have failed to notice the dense tomentum of the lower surface of the leaves, almost as dense as in *Verbascum Thapsus*. Nor would he have described such a plant as "fere glabra,' nor ascribed lobed leaves to *H. tomentosus*. If we are not certain as to what *H. americanus* is, although I think we may be reasonably sure, we are absolutely certain that it is not *H. tomentosus*. I have not seen any plant from the vicinity of Vera Cruz like *Fendler 1277 B*, but that does not prove that it does not grow

there; and since we do not know the source of Linnaeus' plant more clearly than that it came from the warmer parts of America, it is not at all impossible that it came from Venezuela. Accordingly, I consider *Fendler 1277 B*, from Venezuela, the true *H. americanus*, the type of the genus, and I cannot concur in Baker's reduction of *H. tomentosus* to synonymy.

Baker also adds a variety of *H. popayanensis* which he calls *Purdiei*, stating that in this variety "the leaves are much more densely tomentose," but without mentioning a type. The degree of pubescence varies greatly in this genus, and it does not seem to me that such a variable character as degree of pubescence is sufficient to establish the separate identity of even a variety, especially with no type cited. I suppose if there had been other differences they would have been mentioned.

In 1901, J. Donnell Smith published Rose's description of *H. Donnellsmithii*, and in 1905 appeared the second paper by Rose, in which he described *H. laevis*, *H. microcarpus*, and *H. velutinus*. I am unable to separate Rose's *H. microcarpus* from his *H. reticulatus*, published in his first synopsis. Both have tuberculate-appendaged sepals and a short style, and the reticulations of the leaves vary throughout the two groups. There seems at first sight to be a difference in the fruits, but such difference as there is is one of degree. Both are sessile and orbicular, and the faces of both are provided with plumose hairs, but the fruit of the group called *microcarpus* is smaller. On one of Pringle's specimens, No. 9693, are two inflorescences, presumably, error eliminated, from the same plant. If these are from the same plant, it is impossible to separate the two groups. The fruit in this genus remains a long time on the tree, and it is more than probable that the weather might have a marked effect upon such fragile structures as exposed, plumose hairs. I have, therefore, united *H. microcarpus* and *H. reticulatus* under the latter name.

In April, 1904, Brandegee described *H. glaber* from Sinaloa, and in 1905, as already noted, Rose published *H. laevis* from Batanos in the state of Jalisco. In the Gray Herbarium are two specimens from Sinaloa labeled *H. glaber*, one marked "Type" from Cerro Colorado, and the other from the vicinity of Culiacon. There is no town in Sinaloa named Cerro Colorado, but I assume this to be a local name and take it that both plants

are from Sinaloa, near Culiacan, as stated on the label. Brandegee describes his plant as "leaves glabrous" and his type is so, but the other is by no means glabrous, though otherwise the two specimens are identical. I have carefully compared Rose's *H. laevis* with Brandegee's *H. glaber* and, except for slightly varying degrees of pubescence, I am unable to separate them. Moreover, these two groups do not differ in any important character from *H. polyandrus*. The fruit in all three is characteristic and similar, having a narrow fringe and a shallow longitudinal groove on the faces. After careful consideration, I have come to believe that the three groups are one species, and have united them under the name *H. polyandrus* S. Watson.

I am unable to accept Loesener's *H. Caeciliae*, published in 1913. The type is *Seler 4976*, which I have not seen. Loesener's description is very complete except for the flowers. He admits its near relationship to *H. Donnellsmithii* and points out the difference to be, "der [*H. Donnellsmithii*] durch breitere mehr dreieckig kreisförmige Blattspreiten und lockerere Blütenstände von *H. Caeciliae* abweicht." Nothing in his description would prevent his plant from being classified as *H. Donnellsmithii*, and the differences he mentions are well within the limits of fluctuating variation. He mentions, indeed, the densely hirsute faces of the fruit, but says, "videtur nondum plane matura." *Kellerman 6068*, from Guatemala, answers to this description perfectly but is plainly *H. Donnellsmithii*. Rose, describing the latter species, says the densely hirsute faces of the fruit become rugose and glabrate with age.

Hochreutiner, in 1914, published six new species: *H. diclinus H. boliviensis*, *H. glabrescens*, *H. Rosei*, *H. stipulatus*, and *H. ligrinus*. The latter proves not to belong to the genus, and I have strong suspicions about *H. stipulatus*. He describes also a variety of *H. popayanensis*, which he calls *grandifolius*, the difference being that in the variety the leaves are larger and usually not lobed, while the panicle is smaller. There is such variation in these characters throughout the whole group that I am unable to accept the variety and have reduced it to synonymy. Also, Hochreutiner's *H. glabrescens* proves to be identical with Robinson's *H. glanduliferus* and is accordingly united with it. The only difference between these two species is in the degree of pubescence of the leaves which, as I have already pointed out,

is very variable. The fruit and flowers are practically identical. Hochreutiner also points out that *H. Nelsoni* Rose is the same as a plant that was originally incorrectly placed in the genus *Grewia* under the specific name of *terebinthinaceus*. To quote Hochreutiner, "nous avons á l'Herb. Delessert un original du jardin de Montpellier, déterminé par de Candolle et en outre, le no. 1064 de Berlandier, cité par Rose sur l'apui de son *H. Nelsoni*, et ces deux plantes sont identiques." Hochreutiner's conclusion seems tenable.

I have not seen the type of *H. stipulatus*, *Poeppig 3102*, nor any plant of the genus that answers to his description. *Botteri 1110*, Gray Herbarium, does, indeed, fulfil the requirements of the description, but, unfortunately, does not belong to the genus. The inflorescence is, as Hochreutiner says in his description, "divaricata, ramosa plus minus corymbiformis," which is not characteristic of this genus, and the structure of the flower is less so.

Concerning the characters of the genus *Heliocarpus*, it is to be noted that the knowledge acquired by the examination of a large amount of material renders inadequate the diagnoses of Engler and Prantl and of Bentham and Hooker. In *Triumfetta*, a closely allied genus, the apex of the receptacle, above the sepals and petals, is crowned by a saucer-shaped structure with ciliate rim in which repose the ovary and stamens. This structure is not found in any of the undisputed species of *Heliocarpus* but is present in all the species of *Triumfetta* that I have examined. Also, in *Triumfetta*, the sepals are usually, if not always, long-appendaged, while in *Heliocarpus*, the appendages, if any, are short. In *Triumfetta*, the style is usually long and more or less capitate, while in *Heliocarpus* it is invariably bifid with spreading lobes. *Seemann 96* and *Pittier 5017*, both from Panama; *Langlassé 708*, from Guerrero, type of *H. tigrinus;* and *Botteri 1110*, from Vera Cruz, all have these characters of *Triumfetta* and are accordingly considered as not to belonging to the genus *Heliocarpus*.

An effort has been made to render the appended key available for herbarium use. Its artificiality is made necessary by the fact that many specimens will lack either fruits or flowers. I have followed Rose in the division of the group into those with stipitate and those with sessile fruits, but this character must be

determined from the fruit, for the length of the ovarian stipe in even a mature flower is the same in both groups. After anthesis the stipe in the first group elongates, but in the second group no such elongation takes place.

CHARACTERS OF THE GENUS HELIOCARPUS

Trees or shrubs with stellate pubescence. Leaves simple, integral or lobed, petiolate, palmately veined. Inflorescence a panicle. Flowers polygamous or dioecious, four- or five-merous, sometimes apetalous, small, not more than 10 mm. long or broad, regular. Sepals valvate, acute, densely stellate, flat or hooded, often with a small appendage near the apex behind the hood. Petals alternate with the sepals, narrow, glandular, more or less pubescent toward the base. Receptacle with glands opposite the petals. Stamens fourtenn to forty, attached to the receptacle below the ovary, anthers introrse, opening by longitudinal slits, stamens often reduced to sterile filaments in pistillate flowers. Ovary wholly superior, more or less compressed, hairs on the compressed edge usually longer, two-celled, each cell with two ovules separated by a false partition. Style erect, filiform, not more than six or seven times the length of the ovary, bifid, the lobes spreading, simple and acute, or themselves lobed. Fruit indehiscent, *compressed, with a fringe of plumose hairs in two series around the compressed edge.*

Key to the species

Fruit sessile.
- Leaves glabrous both sides or not more than slightly pubescent beneath.
  - Faces of fruit rugose, essentially glabrous, rays thinly plumose. — 1. *H. glanduliferus.*
  - Faces of fruit more or less pubescent.
    - Faces slightly tomentose with some plumose hairs. — 2. *H. pallidus.*
    - Faces not plumose, but short appressed stellate.
      - Fruit oval, rays longer than diameter of the body, body dark. — 3. *H. occidentalis.*
      - Fruit orbicular, rays shorter than diameter of the body. — 4. *H. polyandrus.*
- Leaves more or less pubescent both sides, but especially beneath.
  - Mature leaves integral.

Fruit nearly or quite glabrous. 1. *H. glanduliferus*
Fruit unmistakably pubescent.
Fruit with a shallow groove between the cells, fringe less than diameter of the body, style longer than the ovary. 5. *H. Palmeri.*
Fruit densely tomentose, fringe much exceeding diameter of the body, style longer than the ovary. 6. *H. attenuatus.*
Mature leaves more or less lobed.
Upper surface minutely softly stellate, lower surface smooth, velvety, faces of fruit slightly pubescent, fringe less than diameter of the body. 7. *H. velutinus.*
Leaves more or less tomentose both sides, fringe equal to or longer than diameter of the body.
Leaves markedly reticulate beneath, style twice the length of the ovary, sepals tuberculate or appendaged. 8. *H. reticulatus.*
Leaves not markedly reticulate beneath, and sepals not appendaged.
Fruit clavate, faces densely hirsute, leaves densely stellate both sides. 9. *H. viridis.*
Fruit oval or orbicular, leaves tomentose beneath, faces of fruit with plumose hairs nearly as long as the fringe. 10. *H. terebinthinaceus.*
Fruit stipitate, so far as known.
Mature leaves with persistent stipules. 11. *H. stipulatus.*
Leaves without stipules.
Leaves with conspicuous appendages at the sinus. 12. *H. appendiculatus.*
Leaves without appendages.
Leaves glabrous or pubescent above, but with few to many long, appressed hairs.
Leaves integral, glabrous or glabrate above, densely tomentose beneath. 13. *H. tomentosus.*
Leaves lobed, often only obscurely.
Young stems, but not branches of the panicle, smooth and punctate with white dots, leaves irregularly serrate, lobes acuminate, blade seldom more than 15 cm. in length. 14. *H. americanus.*
Young stems not punctate with white dots, stems, petioles, and branches of the panicle usually flocculent or hirsute, blade of leaves more than 15 cm. long, appressed-stellate beneath. 15. *H. popayanensis.*
Leaves without long, appressed hairs above.

Lower surface thin, appressed-stellate and with conspicuous long, straight hairs on the sides of the nerves. 16. *H. australis.*
Lower surface otherwise.
Leaves suborbicular, distinctly and acutely lobed, flowers strictly dioecious. 17. *H. diclinus.*
Leaves integral or lobed, flowers perfect or polygamous.
Leaves essentially glabrous above and thin, appressed-stellate beneath. 18. *H. Donnellsmithii.*
Leaves more or less densely pubescent both sides.
Pubescence of leaves in dense, separate tufts, larger and longer beneath, nerves not hirsute. 19. *H. rudis.*
Lower surface conspicuously long- and yellow-tomentose in the nerve axils. 20. *H. nodiflorus.*
Leaves otherwise.
Leaves densely tomentose beneath. 21. *H. boliviensis.*
Leaves thin, appressed-stellate beneath, flowers in nodose clusters, style divided more than half way, leaves usually integral, at most obscurely lobed. 22. *H. Rosei.*

1. HELIOCARPUS GLANDULIFERUS Robinson; Rose, Contr. U. S. Nat. Herb. **5**: 127. 1897

H. glabrescens Hochr. Ann. Conserv. Jard. Bot. Genève **18-19**: 122. 1916. = *H. mexicanus* (Bourg.) Sprague

Tree or shrub; young branches glabrate, minutely stellate, *densely clothed with small red glands;* leaves acute or acuminate, serrate, lower serrations glandular, glabrous or slightly pubescent above, lighter beneath, indument varying from essentially glabrous to densely and softly stellate, and villous on the principal nerve axils; panicle small, flowers in dense nodose clusters; sepals five, hooded, appendaged; petals linear, one-nerved, glandular, slightly stellate on the outside toward the base; stamens about twenty; style two and one-half times the length of the ovary, bifid briefly at the tip, lobes acute; fruit sessile, oblong, body 5 × 2 mm., slightly stellate on the faces, *becoming at length glabrous and rugose.*

TYPE: *Heyde 281*, Guatemala (U. S. National Herbarium and Gray Herbarium); *J. Donnell Smith 3956*, Guatemala; *Nelson 2400*, Chiapas; *Tonduz 8453*, Costa Rica; *Renson 61*, Salvador; *Galeotti 4154*, Vera Cruz (type of *H. glabrescens*); *Purpus 2227*, Vera Cruz.

2. HELIOCARPUS PALLIDUS Rose, Contr. U. S. Nat. Herb. **5**: 128. 1897

Tree, 3.5–7.5 m. high; branchlets densely stellate-pubescent; leaves broad-ovate, integral or obscurely lobed, long-acuminate, 5–8 × 3–6 cm., base round, petiole 2–5 cm. long, dark green above, glabrescent, with a *very pale, dense, short, fine tomentum below*, three- to five-nerved, irregularly serrate; panicle open, spreading; sepals four or five, flat, appendaged; petals smaller, one-nerved, slightly stellate on both surfaces near the base; stamens about twenty; style about equal to the ovary, bifid about one-fifth of its length, lobes obtuse; fruit sessile, body *orbicular*, 3 mm. in diameter, faces densely stellate *with a few short plumose hairs*, fringe 4 mm. wide.

TYPE: *Palmer 191*, Chihuahua (U. S. National Herbarium); *Nelson 6970*, Guerrero; *Palmer 157*, Guerrero.

3. HELIOCARPUS OCCIDENTALIS Rose, Contr. U. S. Nat. Herb. **5**: 127. 1897

Tree, 4.5–9 m. high; leaves integral, broadly ovate-lanceolate, base round, long-acuminate, obtusely serrate, above green, glabrescent, beneath densely but very finely, short, appressed-stellate; panicle large and spreading; sepals four or five, slightly hooded, short-appendaged; petals very small, obovate, entire, glandular, three-nerved, slightly stellate toward the base, especially on the edges; stamens about sixteen; ovary rather smal ; style as long as the ovary, bifid, lobes somewhat irregular; fruit sessile, body oval, *very dark*, faces rugose, *with separate stellate tufts*, 3.5 mm. wide, without plumose hairs, fringe 7 mm. wide, very plumose.

TYPE: in the U. S. National Herbarium, number not mentioned, *Palmer 440*, Guerrero; and *986*, Colima cited; *Langlassé 623*, Guerrero; *Pringle 10069*, Guerrero.

The fruit in this species is very characteristic, and the species shows little variability.

4. HELIOCARPUS POLYANDRUS S. Watson, Proc. Am. Acad. **21**: 420. 1886

H. glaber Brandegee, Zoe **5**: 207. 1904.

H. laevis Rose, Contr. U. S. Nat. Herb. **8**: 317. 1905.

Tree or shrub; branchlets and petioles finely puberulent; leaves integral, ovate-lanceolate, cordate, acuminate, essentially glabrous above, slightly erect-stellate beneath, degree of pubescence variable, obtusely serrate; panicle small; sepals five, hooded and appendaged, 4 mm. long; petals linear-obovate,

edges ciliate toward the base, five-nerved; stamens about forty; style much longer than the ovary, briefly bifid at the tip; *fruit orbicular, faces grooved between the cells,* stellate but without plumose hairs, fringe not longer than diameter of the body.

TYPE: *Palmer 100,* Chihuahua, Gray Herbarium; *Palmer 629,* Sonora; *Rose 1694,* Sinaloa.

Owing to variability of leaf-indument, the characteristic fruit is the final criterion of this species.

5. HELIOCARPUS PALMERI S. Watson, Proc. Am. Acad. 21: 420. 1886

Shrub, 2.5–3.5 m. high; branchlets, also of the panicle, and petioles covered with very short stellate tomentum; leaves integral, broad-ovate, acuminate, mature ones subcordate, stellate-puberulent above, densely stellate but not tomentose below, more so on the nerves, 6–14 × 4–9 cm.; panicle leafy and diffuse; sepals five, hooded and appendaged; petals, in the pistillate flowers, none; stamens twenty, only a few sterile filaments in pistillate flowers; ovary much compressed; style shorter than the ovary, bifid, lobes spreading; fruit oblong or orbicular, 3 mm. in diameter, grooved between the cells, faces densely stellate but without plumose hairs, fringe dense, narrower than the diameter of the body.

TYPE: *Palmer 191,* Chihuahua, Gray Herbarium; *Palmer 97,* Chihuahua.

6. HELIOCARPUS ATTENUATUS S. Watson, Proc. Am. Acad. 21: 420. 1886

Shrub, 2.5 m. high; branches and petioles softly stellate; leaves integral, ovate-lanceolate, very long-acuminate, subcordate, rather small, not over 10 × 4 cm., softly and densely stellate but not tomentose, both sides, denser below; panicle rather short; flowers greenish yellow; sepals four or five, hooded, distinctly appendaged; petals linear, narrow, much shorter than the sepals, densely stellate on the outside toward the base, glandular; stamens about 18; ovary only slightly compressed; style twice the length of the ovary, bifid about one-fourth of its length, lobes spreading, acute; fruit oval, 3 mm. long, 2 mm. wide, faces densely hirsute-tomentose, not stellate or plumose, fringe longer than the length of the body.

TYPE: in the Gray Herbarium, number not mentioned; duplicate type, No. 1225, in the U. S. National Herbarium; *Palmer 99,* Chihuahua; *Palmer 647, 732, 733,* Sonora.

7. HELIOCARPUS VELUTINUS Rose, Contr. U. S. Nat. Herb. **8**: 317. 1905

Tree, size not known; branches light brown, densely stellate; leaves three-lobed, suborbicular, about 13 cm. long and wide, cordate, lobes short but acute, upper surface with dense, but very short, fine, stellate tomentum, lower surface with an exceedingly dense and soft white tomentum, both surfaces velvety to the touch; panicle rather large; sepals flat, without appendages, other floral parts not seen; fruit oval, body 5 mm. long, 3 mm. wide, faces rugose, very thinly and softly stellate, fringe narrower than the width of the body.

TYPE: *Pringle 8694*, Morelos, U. S. National Herbarium.

8. HELIOCARPUS RETICULATUS Rose, Contr. U. S. Nat. Herb. **5**: 128. 1897

H. microcarpus Rose, Ibid. **8**: 316. 1905.

Small tree; branchlets, also of the panicle, and petioles densely stellate; leaves broadly ovate, three-lobed, often obscurely, cordate, irregularly serrate, more or less densely stellate both sides and strongly reticulate below; panicle large and spreading in flower, but very compact in fruit; sepals five, slightly hooded, and tuberculate or short-appendaged at the apex; petals, often wanting, very small when present, glandular; stamens about twenty; ovary only slightly compressed; style two and one-half times the length of the ovary, bifid, each lobe having three very small acute lobes; fruit orbicular, faces about 3 mm. in diameter, densely tomentose, with many plumose hairs, fringe about as wide as the diameter of the body, becoming darker in color and much less tomentose with age.

TYPE: number not mentioned, but *Pringle 1791*, Jalisco, is cited. Here also belong: *Pringle 8227, 8719, 9692, 9693*, Morelos; *Rose & Painter 7389, 7390, 7537, 7646*, Jalisco; *Rose 3090, 2496*, Xacetecas, *Rose & Hough 4828*, Jalisco; *Nelson 3520*, Guatemala; *7046*, Guerrero; *Langlassé 572*, Guerrero; *Bourgeau 1200*, Morelos; *Goldman 1024*, Chiapas; *Mr. & Mrs. Lemmon 251*, Morelos.

There is a wide range of variation in the degree of pubescence of the leaves, and in the reticulation of the lower surface.

9. **Heliocarpus viridis** E. E. Watson, sp. nov.

Shrub or small tree; young stems light yellowish brown, longitudinally striolate, white-punctate, stellate-puberulent, smooth; leaves rather small, more or less three-lobed, lobes acute, three-nerved, concolor, crenate, upper surface slightly erect-

stellate, lower surface similar but more densely stellate, especially on the nerves, short-petiolate, the smaller leaves subsessile; panicle small, open, peduncles mostly two-flowered, branches of the panicle densely fine-tomentose; flowers not seen; fruit sessile, oval, somewhat clavate, body 3 mm. long, 2 mm. wide, faces densely tomentose, light colored, fringe about 4 mm. wide.

TYPE: *Rose, Standley & Russell 12828*, Sonora, U. S. National Herbarium.

10. HELIOCARPUS TEREBINTHINACEUS (DC.) Hochr. Ann. Conserv. Jard. Bot. Genève, **18-19**: 125. 1916

H. Nelsoni Rose, Contr. U. S. Nat. Herb. **5**: 127. 1897.
Grewia terebinthinacea DC. Cat. Hort. Monsp. 114.

Shrub, 2.4–6 m. high; young parts scurfy pubescent; leaves broadly ovate, more or less three-lobed, lobes often acuminate, cordate, irregularly serrate, upper surface densely erect-stellate, the hairs in tufts of five or six, crisped, lower surface similar but denser, especially on the nerves, long-petiolate, petioles densely tomentose, blade 11–18 cm. long, 9–16 cm. wide; panicle compact, leafy; buds purplish; sepals four, slightly hooded but not tuberculate or appendaged, glandular; petals none in pistillate flowers; stamens sixteen, sterile in pistillate flowers; ovary slightly compressed, papillose-pubescent; style one and one-fourth times the length of the ovary, bifid about one-fourth of its length, lobes spreading and irregular; fruit only slightly compressed, almost equally covered by plumose hairs, a little shorter on the faces.

The type of *G. terebinthinacea* DC. is not mentioned, but the identity of the latter and *H. Nelsoni* Rose is based upon De Candolle's description of *Berlandier 1064* as *G. terebinthinacea* and its citation by Rose as *H. Nelsoni*. Rose's type of *H. Nelsoni* is *Nelson 1485*, Oaxaca, in the U. S. National Herbarium; *Nelson 1243, 1818*, Oaxaca; *L. C. Smith 937, 797*, Oaxaca; *Rose & Hough 4565*, Oaxaca; *Berlandier 1097*, Oaxaca; *Conzatti 1573*, Oaxaca.

11. HELIOCARPUS STIPULATUS Hochr. Ann. Conserv. Jard. Bot. Genève **18-19**: 121. 1916

H. americanus var. *popayanensis* Schum. in part. in Martius, Fl. Bras. **12**: 11. 1886.

Branches sordid-tomentose; leaves 10–14 cm. long by 9–11 cm. wide, broadly ovate, more or less three-lobed, *stipules persistent*, cordate, irregularly serrate, lower serrations glandular, upper surface dark, minutely stellate, glabrescent, nerves to-

mentose, lower surface lighter, deep green, slightly tomentose (under lens), nerves hirsute; panicles corymbiform; flowers almost sessile, bracts persistent; sepals four or five, linear, tuberculate; petals not much shorter than the sepals; ovary hirsute, style bifid more than half its length, the *androgynophore surrounded by a conspicuous pilose ring*. Fruit not seen.

TYPE: *Poeppig 3102*, Delessert Herbarium, habitat unknown.

I have not seen this specimen, but I strongly doubt the validity of its position in the germs *Heliocarpus*, particularly on account of the pilose ring about the androgynophore and the fact that the species was described without the fruit.

12. HELIOCARPUS APPENDICULATUS Turcz. Bull. Soc. Nat. Moscou **31**: 226, 1858

Probably a tree; young stems and branches of the inflorescence densely scurfy, flocculent-tomentose; leaves broadly ovate, sometimes obscurely and bluntly three-lobed, mature leaves with blade 17 cm. long and 15 cm. wide, long-petiolate, petioles with dense, short, sordid tomentum, upper surface dark green, punctate with short compact tufts, nerves slightly more so, lower surface much lighter, with dense short tomentum, irregularly serrate, base subcordate, *with two conspicuous appendages at the sinus;* panicle leafy and much branched, rather large; flowers very large for the genus; buds 6 mm. long; sepals 4, linear, flat, three-nerved, glandular; stamens about forty; ovary long-stipitate, narrowly oval; style shorter than ovary, deeply bifid, lobes spreading; fruit long-stipitate, oval or orbicular, body about 3 mm. long, faces densely hirsute-tomentose, but without plumose hairs, fringe 4–6 mm. wide, extending down the stipe.

TYPE: *Linden 2065*, Tabasco; *Maxon & Hay 3305, 3306, 3322*, Guatemala; *von Türckheim 7828, 8500*, Guatemala; *Rose & Hough 4314*, Vera Cruz; *Nelson 4385*, San Luis Potosi; *Collins & Doyle 255*, Chiapas.

There is some variability in the appendages at the sinus; usually they are oval or auriculate and entire, but occasionally they are serrate and glandular.

13. HELIOCARPUS TOMENTOSUS Turcz. Bull. Soc. Nat. Moscou **31**: 255. 1858

H. americanus var. *typica* Schum. in part, in Martius, Fl. Bras. **12**: 141.

Small tree; stems and young branches slightly stellate-puberulent; leaves ovate, integral, very rarely lobed, acuminate, base round, petiolate, seldom more than 11 cm. long and 8 cm.

wide, upper surface remotely stellate, with *few* to *many long, appressed, straight* hairs, lower surface densely tomentose, irregularly serrate, three- to five-nerved; panicle large and branched, the branches densely hirsute; sepals four, flat, unappendaged; petals linear, glandular, one-nerved, stellate toward the base on the outside, edges ciliate; stamens about fourteen; ovary small, papillose-pubescent, fringe very evident; style about twice as long as the ovary, bifid about one-fourth of its length; fruit stipitate, oval, body 3.5 mm. long, 2.5 mm. wide, faces densely hirsute, becoming less so with age, without plumose hairs, fringe 5 mm. wide, extending down the stipe.

TYPE: *Linden 857*, Tabasco.

This species is characterized by its leaves, very tomentose below and almost glabrous above. However, there is considerable variability in the indument of the leaves, particularly with regard to the long appressed hairs on the upper surface. These are sometimes entirely wanting, and yet often very abundant. Here belong: *Müller 884, 1049*, Vera Cruz; *Galeotti 4162, 4162B*, Vera Cruz; *Bourgeau 1574, 1719, 1815*, Vera Cruz; *Botteri 340, 341*, Vera Cruz; *Conzatti 1684*, Oaxaca; *Ervendberg 225*, Huasteca; *Goldman 37, 70*, Puebla; *Sutton Hayes 947, 1015*, Panama.

14. HELIOCARPUS AMERICANUS L. Sp. Pl. 448. 1753

H. americanus var. *popayanensis* Schum. in part, Martius, Fl. Bras. 12: 141. 1886.

Shrub or small tree; young stems rather smooth, longitudinally striolate, punctate with white dots; leaves concolor, ovate, more or less three-lobed, subcordate, grossly and irregularly serrate, the ends of the smaller nerves marked by a larger serration in the leaf margin, lobes acuminate, blade seldom longer than 12 cm. or wider than 8 cm., upper surface glabrous except for many long, appressed straight hairs and minutely stellate nerves, lower surface thinly appressed-stellate, nerves and nervelets hirsute; panicle rather small and compact, branches sparsely hirsute and stellate; sepals five, hooded, very shortly appendaged; petals smaller, linear, one-nerved, glandular; stamens about sixteen; ovary compressed, papillose-pubescent, very wide at the base and sessile on the receptacle, although the fruit is stipitate, style a little shorter than the ovary, deeply bifid; fruit stipitate, body oval, 4 mm. long, 3 mm. wide, faces pubescent, becoming glabrate with age, a few of the hairs plumose, fringe about 5 mm. wide, extending down the stipe.

Linnaeus preserved no specimen. Here belongs *Fendler 1277 B*, Venezuela.

15. HELIOCARPUS POPAYANENSIS H. B. K. Nov. Gen. Sp. **5**: 341. 1821

H. trichopodus Turcz., Bull. Soc. Nat. Moscou **31**: 226. 1858.
H. americanus var. *popayanensis* Schum. in part in Martius, Fl. Bras., **12**: 141, 1886.
H. popayanensis var. *grandifolius* Hochr. Ann. Conserv. Jard. Bot. Genève **18-19**: 116. 1915.
H. popayanensis var. *Schumanni* Baker, Jour. Bot. **36**: 132. 1898.
H. popayanensis var. *Purdiei* Baker, l. c.
H. popayanensis var. *trichopoda* Baker, l. c.

Large tree; young stems and branches of the panicle and petiole usually *densely flocculent-stellate*, but often only hirsute or tomentose; leaves vary in form from integral, broadly ovate to acutely three-lobed, being often obscurely lobed, blade of mature leaves 16–20 cm. long, 13–18 cm. wide, minutely and sparsely stellateabove, more so on the nerves, and usually with *long, appressed* hairs, lower surface, densely appressed-stellate, the principal nerves often hirsute; panicle sessile, tri-radiate; sepals four, flat, unappendaged; petals long, linear-obovate, glandular, densely stellate toward the base; stamens about sixteen, ovary slightly compressed, style a little less than twice the length of the ovary, bifid about one-third of its length, the two lobes themselves somewhat lobed; fruit stipitate, body clavate, 4 mm. long, faces with short slender hairs, rarely a few plumose hairs among them, fringe about 4 mm. wide extending down the stipe.

TYPE: in Bonpland Herbarium, Paris, number not mentioned; *Holton 770*, Magdalena, Colombia; *Triand*, Bogota, Colombia; *Rose & Rose 23518*, Ventura, Ecuador; *Bang 1455*, Bolivia (type of var. *grandifolius*); *Fendler 1277*, Venezuela; *Cowell, 270, 271*, Panama; *Spruce*, eastern Peru.

This is a very variable species, and of wide geographical distribution. The variability of the leaves is observable in those of the same tree. The northern representatives are usually smoother than those from the vicinity of Popayan.

16. **Heliocarpus australis** E. E. Watson, sp. nov.

H. americanus var. *typica* Schum. in part in Martius, Fl. Bras. **12**: 141. 1886.

Probably a tree; young stems very smooth, branches of the panicle hirsute and finely appressed-stellate; leaves ovate-lanceolate, integral, very rarely lobed, base round, three-nerved, upper surface minutely stellate, older leaves almost glabrous, dark, lower surface thinly, appressed-stellate, but *conspicuously*

long-hirsute on the nerves especially at the sides, regularly but doubly serrate; panicle rather large and much branched; sepals 4, linear, hooded, *tuberculate at the apex;* petals narrow, obovate, glabrous; stamens about sixteen; ovary small, compressed, faces papillose-pubescent, fringe very evident, style long, four times the length of the ovary, bifid about one-fourth of its length, lobes acute, spreading; fruit stipitate, oval, body 4 mm. long, 3 mm. wide, faces hirsute but without plumose hairs, becoming less so with age, fringe about 4 mm. wide extending down the stipe.

TYPE: *Hassler 557*, Paraguay, in the herbarium of the New York Botanical Garden; *Hassler 557a*, Paraguay; *Curran 9, 17, 700, 718*, Argentina.

17. HELIOCARPUS DICLINUS Hochr. Ann. Conserv. Jard. Bot. Genève **18-19**: 117. 1916

Shrub or tree; branches and young stems gray, puberulent; leaves orbicular, blade not more than 18 cm. long and wide, acutely three-lobed, often obscurely, upper surface *dark, finely stellate-puberulent*, lower surface *much lighter, densely, closely appressed-stellate*, nerves not hirsute; panicle rather small and compact, with *strictly dioecious* flowers on very short pedicels in dense, nodose clusters; buds and flowers very small; sepals four, slightly tuberculate; petals greatly reduced in pistillate flowers, 0.5 mm. long, stamens a few sterile filaments, ovary slightly compressed; style about as long as the ovary, bifid, lobes spreading; fruit not seen.

TYPE: *H. H. Smith 1908*, Santa Marta, Colombia.

18. HELIOCARPUS DONNELLSMITHII Rose; J. Donnell Smith, Bot. Gaz. **31**: 110. *pl. 1.* 1901

H. Caeciliae Loes.; Fedde, Rep. Spec. Nov. **12**: 227. 1913.

Small tree, 8–9 m. high; leaves integral, broadly ovate, short-acuminate, suborbicular at maturity, base round, finely serrate, lower serrations glandular, upper surface, *shining, essentially glabrous, lower surface remotely appressed-stellate*, stellations mostly with three or four rays, nerves slightly hirsute; panicle rather large, very loose, branches *finely stellate* and *slightly hirsute*, smooth; sepals four, slightly hooded, but not appendaged or tuberculate, 5 mm. long in perfect flowers, much smaller in pistillate flowers; petals long, obovate, one-nerved, the nerve dividing into three above, glandular, slightly stellate below on the outside, petals none in pistillate flowers; ovary small, slightly compressed, style three times the length of the ovary, bifid at the tip, ovary larger and style shorter, more deeply lobed in

pistillate flowers; fruit stipitate, oval-orbicular, body about 2.5 mm. in diameter, faces densely hirsute, but without plumose hairs, fringe 4 mm. wide, extending down the stipe.

TYPE: *J. Donnell Smith 1722*, Guatemala. This species seems to be quite widely distributed. Here belong:—*Père Duss 1367*, Martinique; *Curran 7*, Martinique; *Hahn 1340*, Martinique; *Baker 2490*, Nicaragua; *Kellerman 6068*, Guatemala; *Goll 255*, Guatemala; *Rovirosa 120*, Tabasco; *C. L. Smith 1002*, Vera Cruz.

19. **Heliocarpus rudis** E. E. Watson, sp. nov.

Tree, 15–25 m. high, bark smooth; young stems and branches of the panicle and petioles with *dense, ferruginous, tufted pubescence*, rough to the touch; leaves very broadly ovate, irregularly serrate, three-lobed but not deeply, often integral, lobes acute, deeply cordate, coarse in texture, very dark above, much lighter below, five- to seven-nerved, upper surface with *dense, separate, short, yellowish tufts* on the nerves and nervelets, lower surface with similar but *very much larger* tufts, and occasionally a tuft of four or five long, slender, flexible hairs 8–9 mm. in length, mature leaves 18 cm. long and wide, petioles 12 cm. long; panicle rather small; flowers unisexual or polygamous; pistillate flowers with 4 sepals, hooded and tuberculate, petals none, stamens a few sterile filaments; ovary slightly compressed, papillose-pubescent, fringe very evident, style a little longer than the ovary, bifid, each lobe dividing into three short acute lobes; staminate flowers not seen; fruit orbicular, short-stipitate, stipe less than 2 mm., body 4 mm. in diameter, faces rugose, slightly hirsute, with a few plumose hairs, about one-eighth as long as the fringe which is 5 mm. wide.

TYPE: *Pittier 3082*, Panama, in the U. S. National Herbarium.

20. HELIOCARPUS NODIFLORUS (Donnell Smith) Donnell Smith & Rose, Contr. U. S. Nat. Herb. **5**: 126. 1897

H. polyandrus var. *nodiflorus* Donnell Smith, Bot. Gaz. **23**: 240. 1897.

Tree; branches longitudinally striolate, very smooth, slightly stellate and hirsute, glabrescent; leaves integral, broad ovate, blade 18 × 14 cm. wide, often smaller, petioles 10 cm. long, doubly serrate, upper surface thinly stellate, more densely on the nerves, lower surface moderately dense appressed stellate, conspicuously dense, yellow, tomentose *in the nerve axils*, and at the attachment of the petiole, petioles glabrate, panicle rather small, leafy; flowers in *dense, nodose*, clusters; sepals four, hooded, tuberculate; petals smaller than sepals, four-nerved, very glan-

dular, densely stellate below on both surfaces; ovary compressed, papillose pubescent, fringe very evident; stamens about twenty; style twice as long as ovary, briefly bifid; fruit long stipitate, body oval, 3 mm. in diameter, faces hirsute but without plumose hairs, fringe about 4 mm. wide, hairs of the fringe somewhat sinuous.

TYPE: *Heyde & Lux 4329* in part, Guatemala; *Heyde & Lux 4177*, Guatemala; *Heyde 637, 658*, Guatemala; *Nelson 3742* Guatemala.

21. HELIOCARPUS BOLIVIENSIS Hochr. Ann. Conserv. Jard. Bot. Genève **18-19**: 118. 1916.

Tree; young branches puberulent, punctate with white dots; leaves integral, often obscurely lobed, cordate or round at base; doubly serrate, lower serrations glandular, upper surface erect stellate, *particularly on the nerves*, dark; lower surface, lighter, densely tomentose; panicle large, leafy, branches pallid, brown pubescent, velvety; sepals four, hooded, slightly tuberculate at the apex, the tubercle being dark in color and *glabrous;* petals smaller, glandular; ovary compressed, pappilose pubescent, fringe evident, style as long as the ovary, deeply bifid; fruit stipitate, faces densely hirsute, without plumose hairs, (only immature fruit seen).

TYPE: *Bang 1491*, Bolivia.

22. HELIOCARPUS ROSEI Hochr. Ann. Conserv. Jard. Bot. Genève **18-19**: 119. 1916

Tree, 9 m. high; branches smooth, pilose; leaves integral, sometimes obscurely lobed, broad ovate, irregularly serrate, serrations remote and short, lower glandular, often glandular-appendiculate, blade often very large, 19 cm. long, 15 cm. wide; petioles rather short, not more than 8 cm.; upper surface minutely stellate, especially on the nerves, lower surface thinly stellate, stellations somewhat appressed, nerves slightly hirsute; panicle corymbiform, branches velvety; flowers in nodose clusters; sepals flat, not appendaged or tuberculate; petals long, obovate, glandular, three-nerved, slightly stellate at the base; stamens sixteen, filaments rather coarse, with an obvious nerve; ovary compressed, papillose-pubescent, style as long as ovary, *bifid almost its whole length;* fruit not seen.

TYPE: *Bang 2305*, Bolivia.

NOTE

23. HELIOCARPUS OBLONGIFOLIUS Turcz. Bull. Soc. Nat. Moscou. 36: 226. 1858

Shrub; stems glabrous; leaves petiolate, ovate-oblong, acuminate, irregularly crenate, five-nerved, short stellate both sides; peduncles axillary, one-flowered. Habitat Brazil.

This very inadequately described species is reported from Brazil, exact location and collector being unknown to Turczaninow. No type is mentioned. I have not seen any specimen that fulfils the requirements of the description, and I consider the species very doubtful.

INDEX TO AMERICAN BOTANICAL LITERATURE
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The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in the broadest sense.

Reviews, and papers that relate exclusively to foresty, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions, their kindness will be appreciated.

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